

CAPACITIVE PRESSURE SENSOR

TECHNICAL FIELD

[0001] The present invention generally relates to a capacitive pressure sensor, e.g. for use as an input device for human-appliance interaction (touchpad, keypad, slider, pressure sensing mat, etc.).

Background Art

[0002] Capacitive pressure sensors as such are well known in the art. Such a sensor generally comprises a capacitor, whose capacitance varies as a function of pressure. It is, for instance, known to build a capacitive switch, comprising a first capacitor electrode made of bulk metal and a second capacitor electrode also made of bulk metal, arranged at a certain distance from the first capacitor electrode by an insulating foam spacer. As the first and second electrodes are brought closer together under the action of a compressive force acting on the pressure switch, the capacitance of the capacitor increases. An evaluation circuit detects this increase of capacitance. If the capacitance exceeds a certain predefined threshold, the evaluation circuit triggers some action associated with the capacitive switch. Such capacitive switches are, for instance, used in computer mouse buttons.

GENERAL DESCRIPTION OF THE INVENTION

[0003] The present invention provides a capacitive pressure sensor, which is robust and can be manufactured at low costs.

[0004] The capacitive pressure sensor comprises a laminated arrangement with a first flexible, electrically insulating carrier film carrying a first capacitor electrode, a second flexible, electrically insulating carrier film carrying a second capacitor electrode and a flexible, electrically insulating spacer film sandwiched between the first and second carrier films. The spacer film has a through-hole or recess therein, with respect to which the first and second capacitor electrodes are arranged opposite one another, in such a way that the first and second electrodes are brought closer together by resilient bending of the first and/or second carrier film into the through-hole or recess under the action of a compressive force acting on the pressure sensor. The capacitive pressure sensor is advantageously configured and arranged so that a short-circuit between the first and second capacitor electrodes is prevented even for relatively high pressure. This is the case, for instance, if at least one of the first and second capacitor electrodes is arranged on the surface of the respective carrier film that faces away from the spacer film. In this configuration, the carrier layer itself prevents contact between the electrodes. In another suitable configuration, the spacer film does not have a through-hole therein but a recess, whose depth is inferior to the thickness of the spacer film. If the spacer film has a through-hole therein, if the first capacitor electrode is arranged on the surface of the first carrier film that faces the spacer film and if the second capacitor electrode is arranged on the surface of the second carrier film that faces the spacer film, a short-circuit may be avoided by a dedicated electrically insulating layer arranged on at least one of the first and second capacitor electrodes.

[0005] An advantage of a laminated capacitive pressure sensor as recited above is that it can be produced with low thickness, e.g. in the range from 0.1 to 1 mm, more preferably in the range from 0.2 to 5 mm. Typically, the carrier films and the spacer film have a thickness ranging from 25 μm to some

hundreds of μm . The reduced thickness of such laminated capacitive pressure sensor makes it interesting for a broad range of applications, e.g. in pressure-sensing mats for detecting and/or classifying a passenger on a vehicle seat, in keypads or touchpads for electronic appliances (mobile phone, personal digital assistant, handheld game console, computer, and so forth).

[0006] According to a preferred embodiment of the invention, the first and or the second carrier film and/or the spacer film comprises one or more layers made of thermoplastic polymer material, such as e.g. PET, PEN, PI, PEEK, PES, PPS, PSU and mixtures thereof. Combining different materials allows one to tailor the flexibility, shear and tear resistance, and to improve sensor reliability. The electrodes are preferably conductive polymer thick film electrodes, formed by printing of conductive ink onto the first and/or the second carrier film. Preferably, the flexible spacer film is configured as a double-sided adhesive.

[0007] Most preferably, the gap between the first and second capacitor electrodes (i.e. the opening or recess) does not comprise a foam material arranged therein but is only filled with gas. Conveniently, this gas is air; nevertheless, other gases (e.g. N_2 , Ar, CO_2 or mixtures thereof) are also suitable.

[0008] Advantageously, the capacitive pressure sensor comprises an evaluation circuit operatively connected to the first and second capacitor electrodes and configured for determining a quantity indicative of capacitance (and thus of the pressure) between the first and second capacitor electrodes. Preferably, the evaluation circuit is configured for operating in two modes of operation: in the first mode of operation, the evaluation circuit determines a quantity indicative of capacitance between the first capacitor electrode and ground and, in the second mode of operation, the evaluation circuit determines a quantity indicative of capacitance between the first and second capacitor electrodes. Those skilled will appreciate that such a capacitive pressure sensor combines proximity sensing (in the first mode of operation) with pressure sensing (in the second mode of operation).

[0009] As will be appreciated, the invention is not limited to a capacitive pressure sensor comprising a single pair of capacitor electrodes, which is of course the simplest embodiment. The first carrier film could carry, for instance, a plurality of first capacitor electrodes, each one of the first capacitor electrodes being arranged opposite a common second capacitor electrode. Alternatively, both the first and the second carrier films could carry a plurality of capacitor electrodes, each one of the capacitor electrodes on the first carrier film being arranged opposite a respective one of the capacitor electrodes on the second carrier film. Other variants for arranging first and second capacitor electrodes (e.g. first and second capacitor electrodes offset with respect to one another; first electrodes arranged in groups, wherein the members of a group are arranged opposite a common second electrode; etc.) are deemed within the reach of those normally skilled in the art.

[0010] As will be apparent to those skilled in the art, a capacitive pressure sensor as generally described hereinbefore can be manufactured by applying the first capacitor electrode onto the first flexible carrier film and the second capacitor electrode onto the second flexible carrier film, providing a flexible spacer film with an opening or recess; and laminating together the first flexible carrier film carrying the first capacitor electrode, the spacer film and the second flexible carrier film carrying the second capacitor electrode in such a